

M224XE DISK DRIVES

OEM MANUAL

FUJITSU LIMITED

Communications and Electronics

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CHAPTER 1 GENERAL DESCRIPTION

1.1 Introduction

The M224XE disk drives are compact (mini-floppy size), inexpensive, and highly reliable fixed disk drives developed for random access files in small computers, word processors, and terminals.

The storage capacities (unformatted) for the models are: 85.8 MB for the M2244E, 120.2 MB for the M2245E, and 171.7 MB for the M2246E.

To make system design easier for the user, a simple host interface controller board based on SCSI is now available as an option.

The M224XE interface is an Enhanced Small Disk Interface (ESDI), with high data integrity and intelligent diagnostics. It has superior freedom in sending self-recognition data, and in structuring systems.

1.2 Features

(1) Compact size

Since the disks are 130 mm (5.12 in.) in outer diameter and are driven by a DC motor directly connected to the spindle, the unit is extremely compact in size:

146 mm (5.7 in.) (W) × 83 mm (3.3 in.) (H) × 203 mm (8.0 in.) (D)

(2) High speed positioning

Using a rotary voice coil motor for head positioning results in high speed positioning.

(3) High reliability

The Whitney-type heads, disks, and positioners are completely sealed in the disk enclosure (DE), which has breather and recirculation filters to keep the air clean, thereby increasing reliability and preventing head crashes.

(4) No preventive maintenance

(5) DC power

The direct-drive DC motor requires no adjustment for line frequencies (50 Hz/60 Hz) or input power voltages (100 V, 115 V, 220 V or 240 V).

(6) 5.25-inch mini-floppy disk drive size compatibility

Because its physical size is the same as that of a mini-floppy disk drive, this unit can replace a mini-floppy disk drive without cabinet redesign.

(7) Vertical or horizontal installation

The unit may be installed in its cabinet either vertically or horizontally. (See Section 4.2).

(8) Low power consumption

The power consumption is 30 W (typical). This low power consumption enables the unit to be used in a wide environmental temperature range (5°C to 45°C) without a cooling fan.

(9) Low noise

The unit's low noise output, approx. 45 dB (A-scale weighting) even during seeking, makes it ideal for office use.

(10) Low vibration

The drive has four rubber vibration isolators, which minimize the transfer of motion.

(11) LSI and microprocessor controlled

LSIs and a microprocessor are used on the main printed circuit board to achieve high reliability.

(12) Controller board M1054A (option)

The optional SCSI interface controller board lightens the host load in system design. And because the controller board is the same shape as the drive itself, it can be mounted on the case.

CHAPTER 2 SPECIFICATIONS

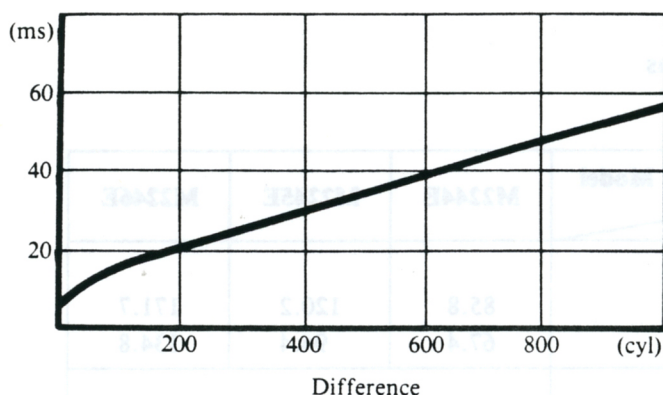
2.1 Functional Specifications

Specification \ Model	M2244E	M2245E	M2246E
Total storage capacity			
Unformatted (MB)	85.8	120.2	171.7
Formatted*	67.4	94.4	134.8
Storage capacity/track			
Unformatted (B)		20,864	
Formatted* (B)		16,384	
Number of disks	3	5	6
Number of heads (R/W)	5	7	10
Number of cylinders	823	823	823
Number of tracks/cylinder	5	7	10
Number of sectors	Variable, 16/32/64		
Recording density (BPI)	20,400		
Track density (TPI)	850		
Transfer rate (KB/S)	1,250		
Rotational speed (rpm)	3,600		
Average latency time (ms)	8.3		
Recording method	RLL (2/7)		
Positioning time Min. (ms)	5		
Avg. (ms)	28		
Max. (ms)	50		
Input voltage**	+ 12V $\pm$ 5%, 1.8A (max. 4.8A) + 5V $\pm$ 5%, 1.6A		
External size			
Width $\times$ height $\times$ depth (mm)	146 $\times$ 83 $\times$ 203 (w/o panel dimensions)		
Disk size (mm)	Outer diameter 130, Inner diameter 40		
Weight (kg)	3.0		

*256 bytes/sector for 64 sectors

**Meets voltage tolerance for unit power supply connectors

2.1.1 Positioning time



2.1.2 Start and stop time

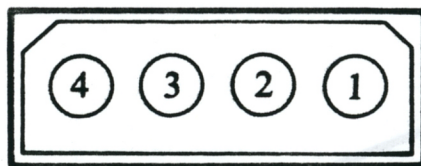
Start time (time from when power is turned on until the unit is ready) is 20 seconds or less, and stop time (time to completely stop when power is turned off) is 15 seconds or less using dynamic braking to prevent disk and head wear.

2.2 Environmental Conditions

Temperature	Operating	5°C to 45°C
	Non-operating	– 40°C to 60°C
	Gradient	15°C/h or less
Relative humidity	Operating	20% to 80% RH
	Non-operating	5% to 95% RH
		Moisture must not condense.
Vibration	Operating	Less than 0.2G (3 to 100 Hz) 2min × 30 cycles (except resonance point) (sinusoidal waveform)
	Non-operating (power-off state after installation)	Less than 0.4G (3 to 100 Hz) 2 min × 30 cycles (sinusoidal waveform)
Shock	Operating	Less than 2G (maximum 10ms)
	Non-operating	Less than 20G (maximum 10ms)
Altitude above sea level	Operating	3,000m or below
	Non-operating time	12,000m or below

2.3 Power Requirements

(1) Power connector pin assignment



From cable side

1	+ 12 V
2	+ 12 V RTN
3	+ 5 V RTN
4	+ 5 V

(2) Input voltage tolerance and current

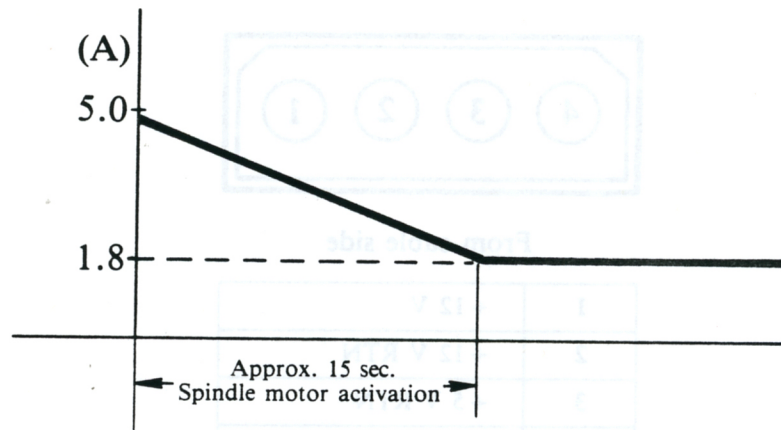
	Input voltage	Peak current	Average current
+ 12 V	+ 12 V $\pm 5\%$	4.8 A	1.8 A
+ 5 V	+ 5 V $\pm 5\%$	–	1.6 A

(3) Power consumption

Steady state 30 W

(4) Current waveforms

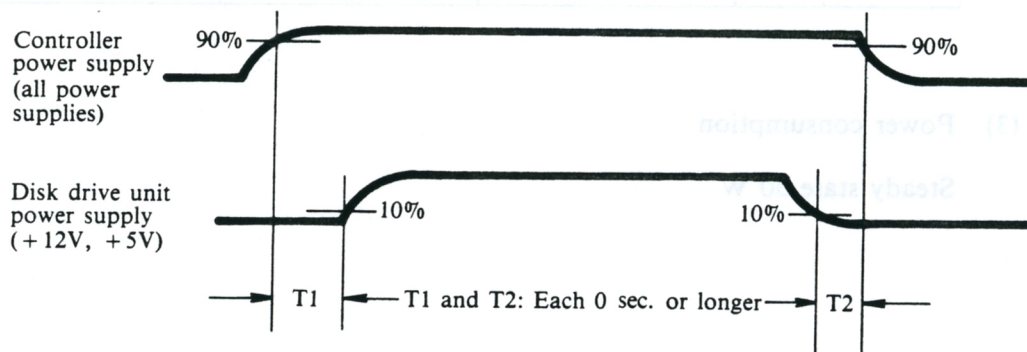
+12 V current waveform (for reference)



(5) Power on/off sequence

If the Write Gate signal from the controller is off before applying or removing power, the voltages (+12 V, +5 V) to the drive need not be sequenced. That is, recorded data will not be destroyed nor will mechanical or electric problems occur. To maintain the Write Gate signal in the off state at the time of drive power-on or -off, the basic sequence between the power supply of the controller and drive is as follows:

a. Basic sequence



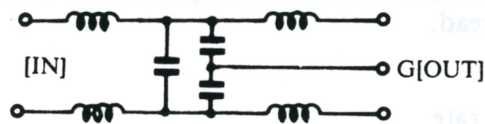
Note: The power supplies of the drive (+12 V, +5 V) need not be sequenced in this case.

- b. If the controller and the drive share a common supply and the Write Gate interface signal is determined only by +5 V, power sequencing is unnecessary. This is so because the +5 V level is monitored within the drive.

(6) Others

To eliminate AC line noise, a noise filter of the specifications given below should be incorporated in the AC input terminal of the drive power supply.

Attenuation characteristics: 40 dB or greater at 10 MHz
Circuit configuration: T type shown below is recommended.



2.4 Reliability

(1) Mean Time Between Failures (MTBF)

The estimated MTBF of the M224XE during its life time is 20,000 hours after an initial 3-month period.

Note: The MTBF is defined as follows.

$$\text{MTBF} = \frac{\text{Operating time (hours)}}{\text{The number of equipment failures from all field sites}}$$

Operating time is the total time duration during which the power is ON.

Failure of the equipment means failure that requires either repairs, adjustments, or replacement. Mishandling by the operator, failures due to bad environmental conditions, power trouble, controller trouble, cable failures, or other failures not caused by the equipment are not included.

(2) Mean Time To Repair (MTTR)

MTTR is the average time taken by a well-trained service mechanic to diagnose and repair a unit malfunction. The M224XE is designed for a MTTR of 30 minutes or less.

(3) Service life

Overhaul of the M224XE is not required for the first five years.

(4) Power loss

Integrity of the data on the disk is guaranteed against all forms of abnormal DC power failure except a power failure during writing.

2.5 Error Rate

Errors detected upon initialization and replaced by an alternate record are not included in the error rate.

(1) Recoverable error rate

A recoverable error which can be read correctly within 16 retries should not exceed 10 errors per 10^{11} bits read.

(2) Non-recoverable error rate

An error which cannot be recovered even 16 retries should not exceed 10 errors or less per 10^{13} bits.

(3) Positioning error rate

The rate of positioning errors recoverable by one retry is 10 or less per 10^7 seeks.

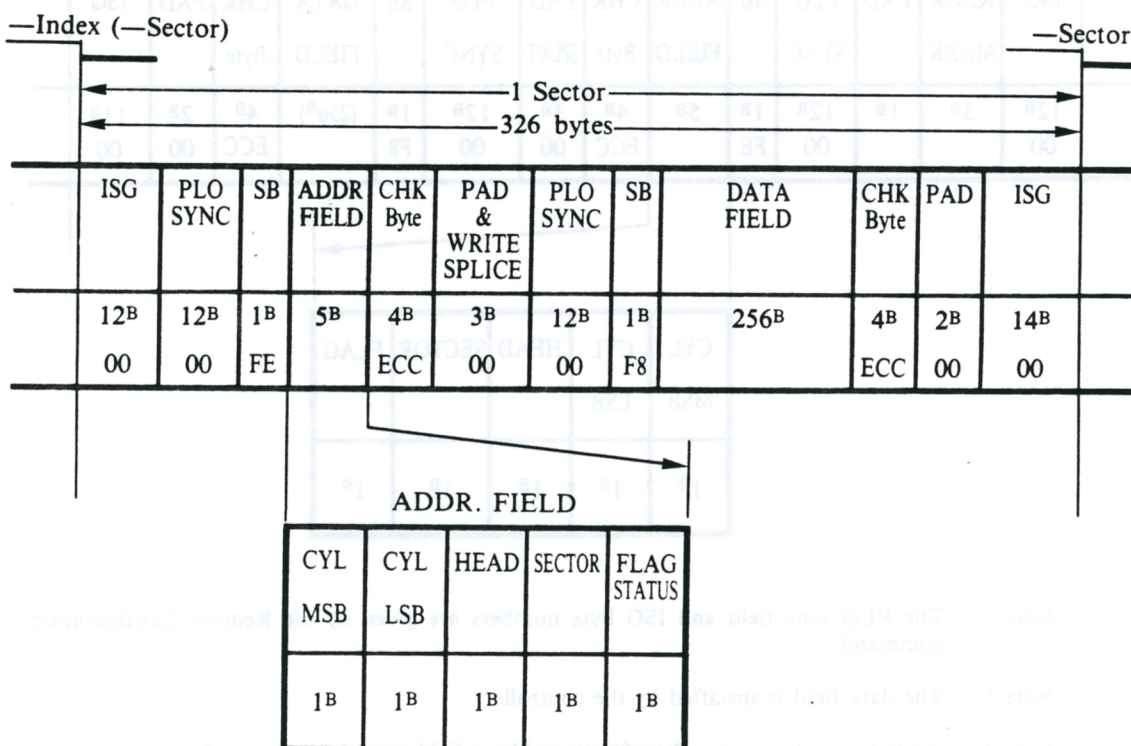
(4) Media error

- a. Cylinder 0, Heads 0 and 1 are defect free.
- b. The number of defects in the M224XE are as follows:
M2244E...
M2245E... TBD
M2246E...

2.6 Data Format

There are two types of data format—fixed length sector format and soft sector format. Recommended formats are given below.

2.6.1 Fixed length sector format

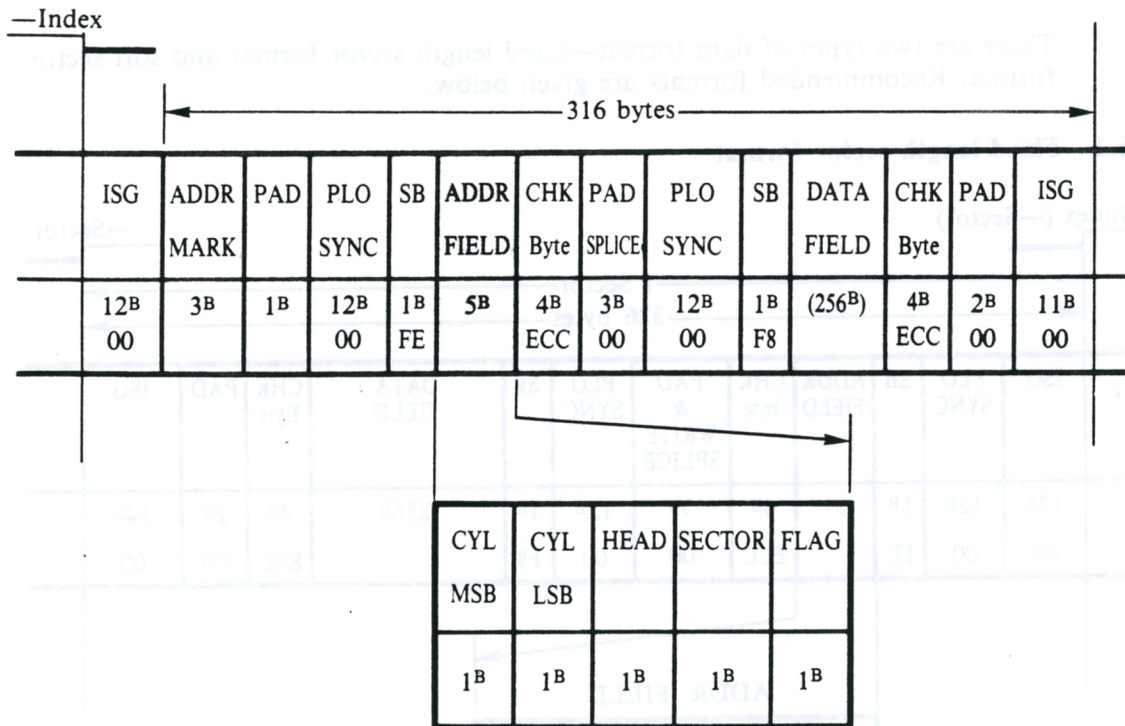


Note 1: The above formats are for 64-sector tracks.

Note 2: The PLO sync field and ISG byte numbers are given by the Request Configuration command.

Note 3: All byte numbers other than for the address field are minimum numbers.

2.6.2 Soft sector format



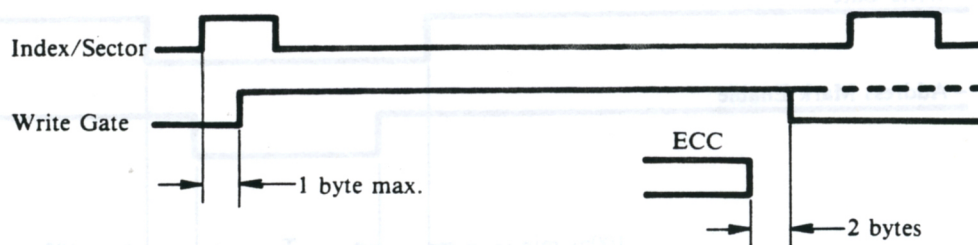
Note 1: The PLO sync field and ISG byte numbers are given by the Request Configuration command.

Note 2: The data field is specified by the controller.

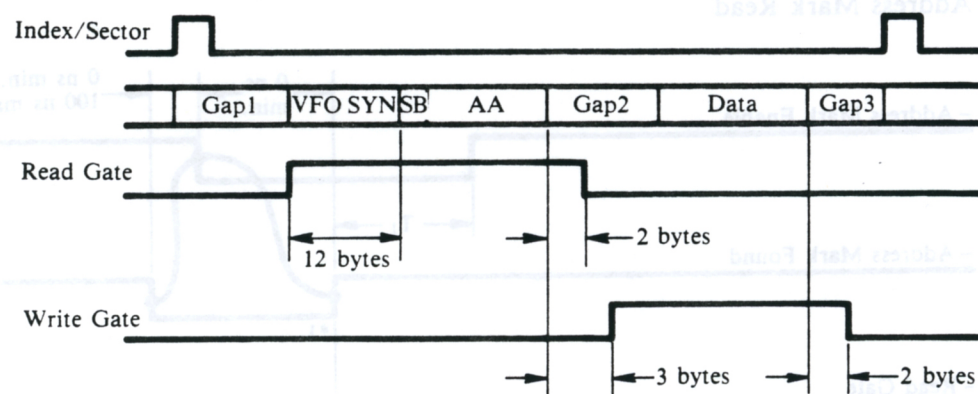
Note 3: All byte numbers other than for the address field are minimum numbers.

2.6.3 Fixed length sector read/write timing

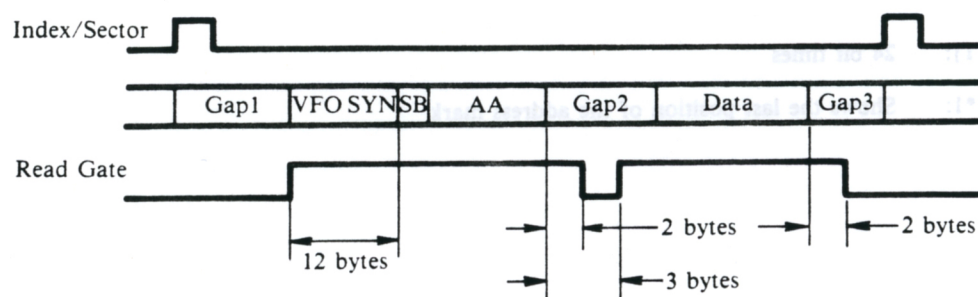
(1) Format Write



(2) Data Write

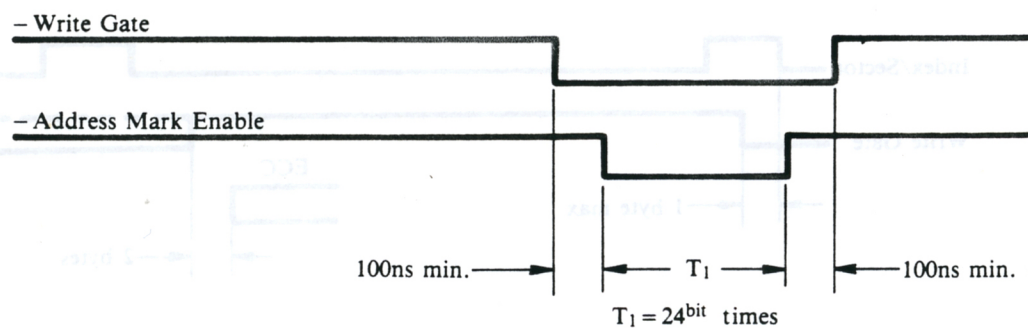


(3) Data Read

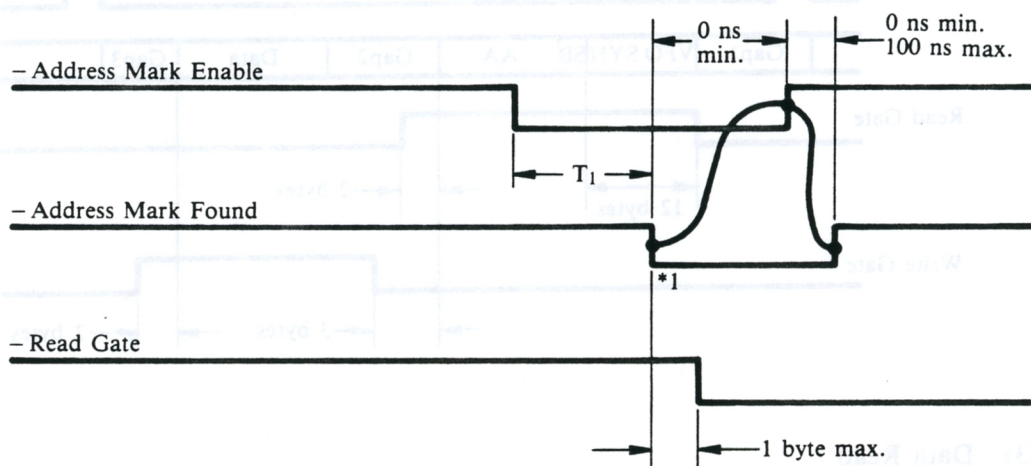


2.6.4 Soft sector read/write timing

(1) Address Mark Write



(2) Address Mark Read



T_1 : 24 bit times

$*1$: Shows the last position of the address mark

CHAPTER 3 CONFIGURATION

3.1 Mechanical Configuration

Figure 3.1 shows the structure of the drive.

The M224XE disk drive consists of disks, heads, spindle motor, actuator, cover, breather filter, recirculation filter, base, Read/Write preamplifier (PCB), power amplifier (PCB), and control (PCB).

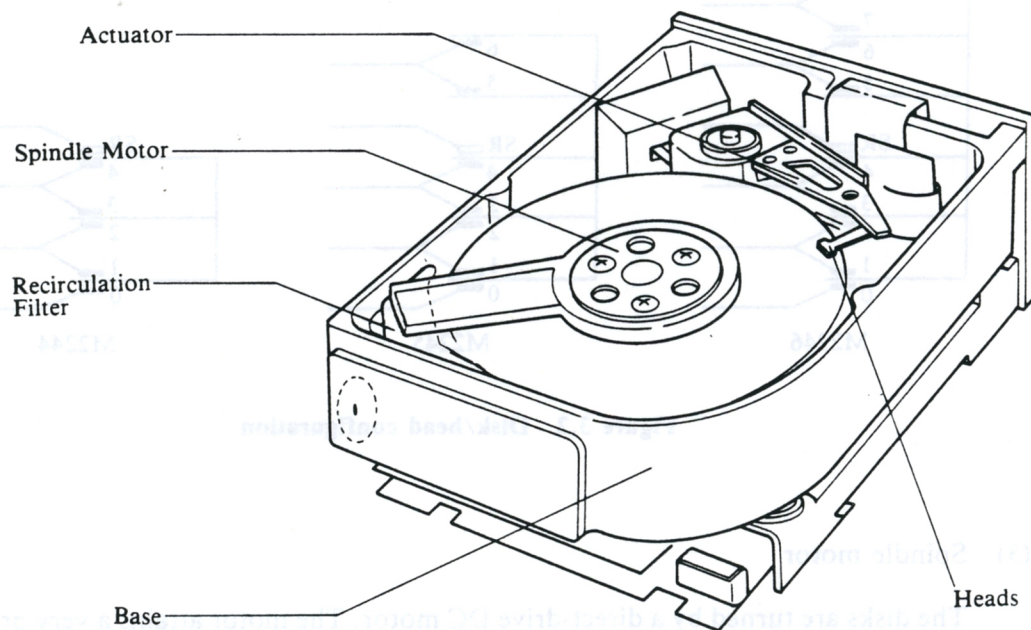


Figure 3.1 Structure

(1) Disks

The Winchester-type disks have an outer diameter of 130 mm and inner diameter of 40 mm, and are coated with a special lubricating material. The M2244 uses three disks; the M2245, five; and the M2246, six. The disks are good for at least 10,000 starts and stops.

(2) Heads

The Whitney-type contact start/stop heads are in contact with the disks when the disks are not moving, but automatically float when the rotation reaches nominal speed. There are 5 read/write heads in the M2244, 7 in the M2245, and 10 in the M2246. The third disk has a prewritten servo pattern for servo head seek control and for obtaining read/write control information.

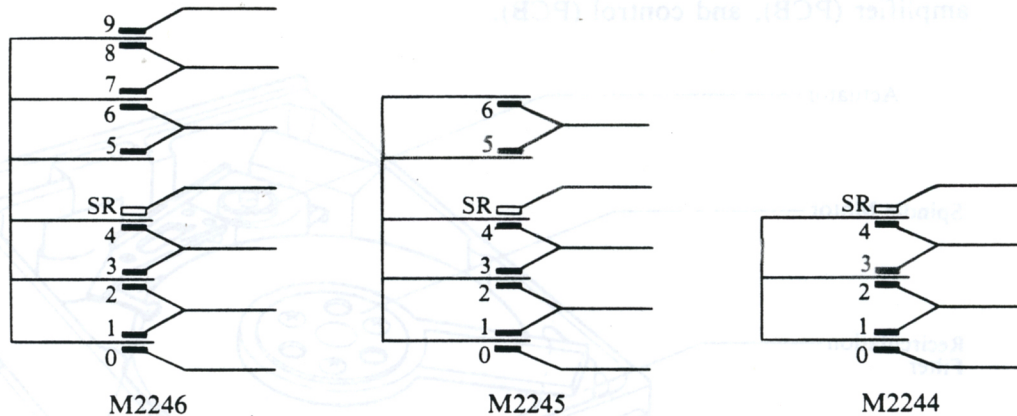


Figure 3.2 Disk/head configuration

(3) Spindle motor

The disks are turned by a direct-drive DC motor. The motor attains a very precise rotational speed of 3600 rpm, $\pm 1\%$. This precision is achieved through a feedback circuit which includes Hall-effect elements mounted within the motor assembly.

(4) Actuator

The actuator, which has a rotary VCM structure, consumes little power and generates little heat. The head assembly on the tip of the actuator arm is controlled by electrical feedback from servo information read out through the servo head. Servo information is used as a control signal activating the actuator. It is used as track cross information in positioning, and track following information in track following.

(5) Air circulation

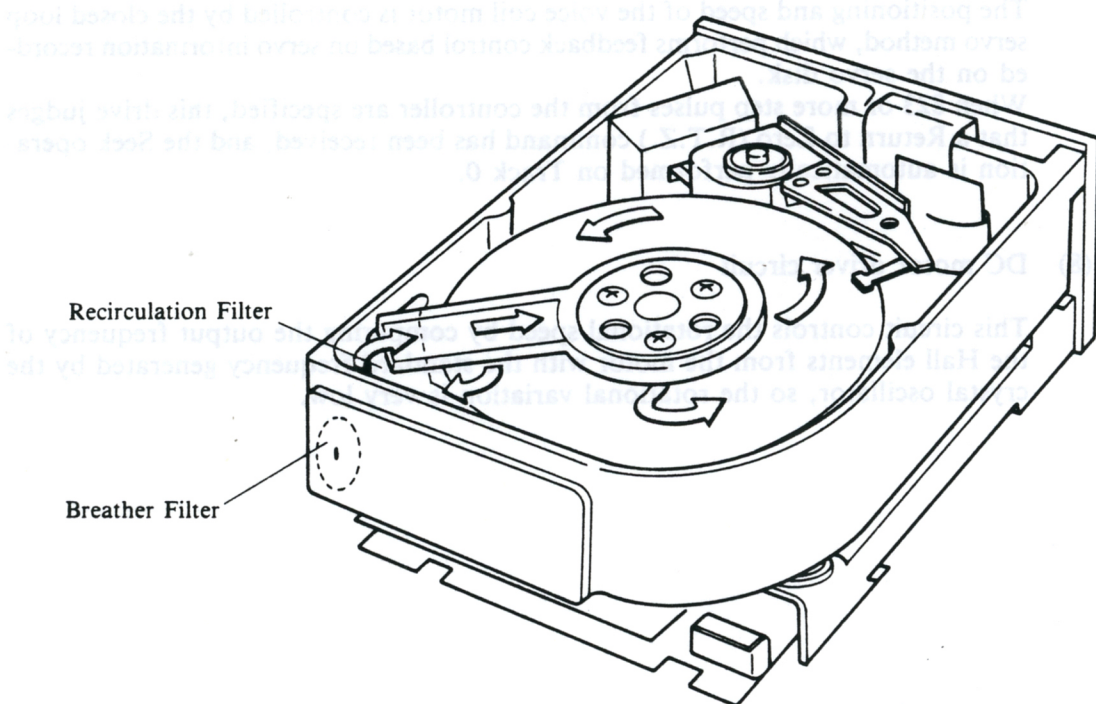


Figure 3.3 Air circulation

The heads, disks, and actuator are sealed inside a cover to keep out dust and other pollutants (Figure 3.3).

To filter dust generated inside the enclosure, the disk blower effect is used to circulate air through the recirculation filter as the disk rotates, thereby keeping inside air at an acceptably clean level.

A breather filter prevents outside dust from mixing with the air entering the cover, and equalizes internal air pressure with atmospheric pressure, as it filters air from the outside.

(6) Read/write circuit

The read/write circuit uses LSIs and head ICs to prevent errors caused by external noise, and to increase data reliability.

Controller load is reduced and controller design made easier by the VFO circuit and RLL data modulation circuits.

(7) Servo circuit

The positioning and speed of the voice coil motor is controlled by the closed loop servo method, which performs feedback control based on servo information recorded on the servo disk.

When 823 or more step pulses from the controller are specified, this drive judges that a Return to Zero (R.T.Z.) command has been received, and the Seek operation is automatically performed on Track 0.

(8) DC motor driver circuit

This circuit controls the rotational speed by comparing the output frequency of the Hall elements from the motor with the standard frequency generated by the crystal oscillator, so the rotational variation is very low.

3.2 Cables

The recommended cable connector specifications are listed in Table 3.1.

Table 3.1 Cable connector specification

Connector	Name	Spec. No.	Manufacturer
A cable (50P)	Cable connector	FCN-767J034-AU/1 or 88373-3 or 3463-0001	FUJITSU AMP 3M
	Drive card edge	—	—
	Cable	455-248-34 or 171-34	SPECTRA-STRIP ANSLEY
B cable (20P)	Cable connector	FCN-767J020-AU/1 or 88373-6 or 3461-0001	FUJITSU AMP 3M
	Drive card edge	—	—
	Cable	455-248-20 or 171-20	SPECTRA-STRIP ANSLEY
Power cable (AMP type)	Cable connector	1-480424-0	AMP
	Drive connector	350211-1	AMP
	Contact	170121-4	AMP
	Cable	AWG 18 (+5V, RTN) AWG 18 (+12V, RTN)	—
SG cable	Fasten receptacle for cable side	62187-1	AMP
	Fasten tab for the drive	61761-2	AMP
	Cable	AWG 20	

3.3 Options

The M1054A intelligent disk controller that can control four M224XE drives is available as an option. The M1054A11 controller option can be used by mounting it directly on the M1054A.

Table 3.2 shows the M1054A and M1054A11 specifications. For further specification details, refer to the following manual.

M1054A INTELLIGENT DISK CONTROLLER OEM MANUAL

Document code: B05P-2180-0401A

Table 3.2 Options

Item	Controller	Specification	Remarks
1	M1054A microdisk controller	B05B-2180-B401A	
2	M1054A11 controller option	B05B-2180-H401A	M4 mounting screw
3	M1054A11 controller option	B05B-2180-H401A #N	# 6-32UNC mounting screw

CHAPTER 4 INSTALLATION

4.1 Outer Dimensions

Figure 4.1 shows the outer dimensions and mounting dimensions. All dimensions are in millimeters.

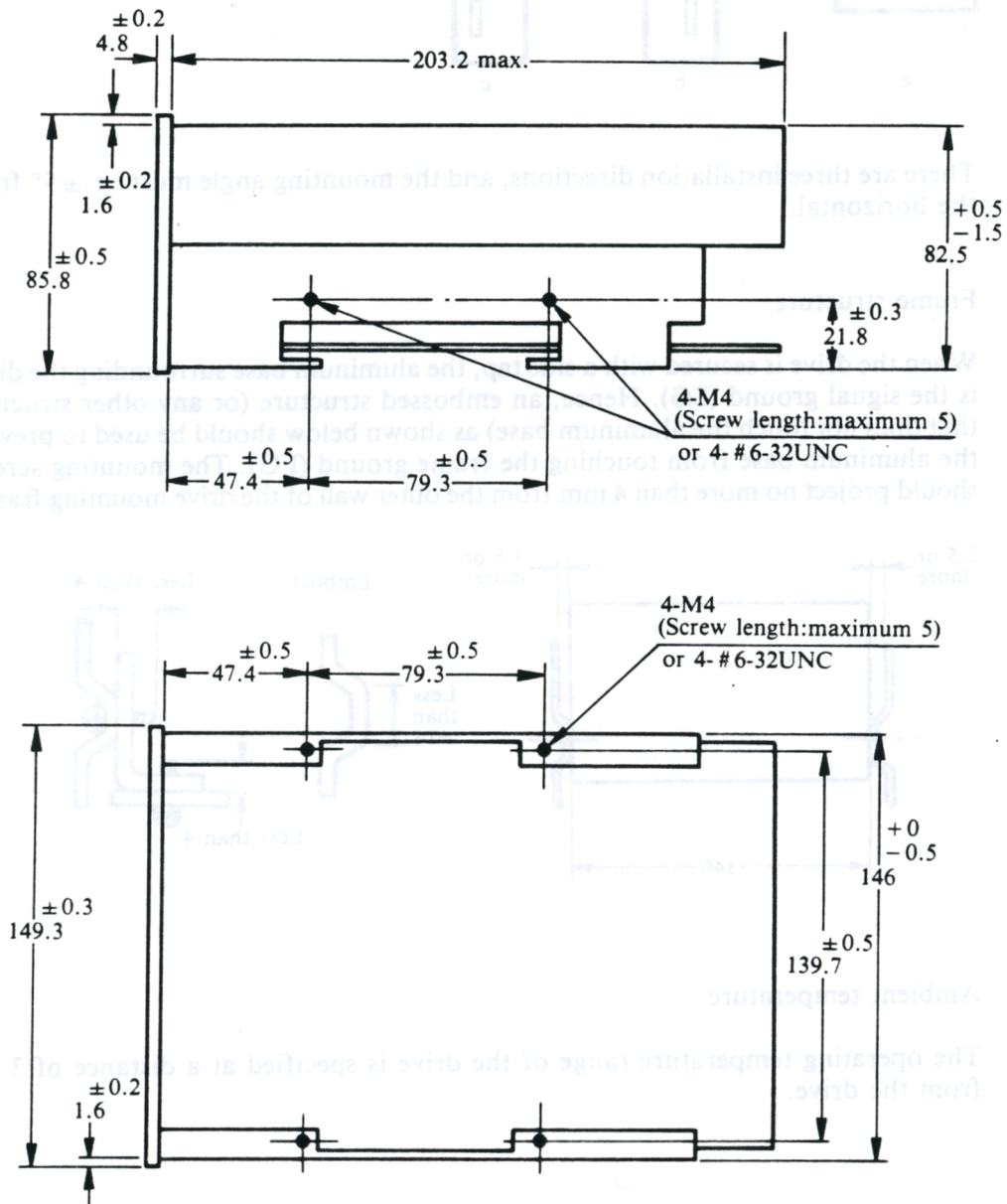
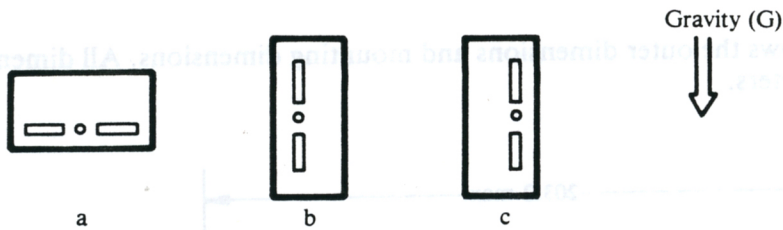


Figure 4.1 Outer dimensions

4.2 Notes on Installation

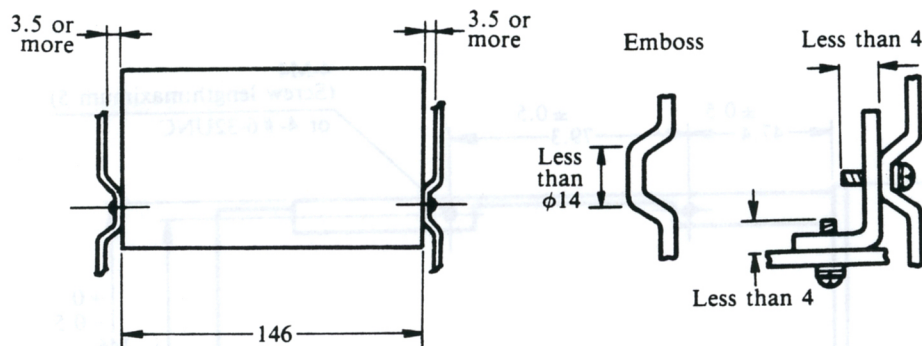
(1) Installation direction



There are three installation directions, and the mounting angle must be $\pm 5^\circ$ from the horizontal.

(2) Frame structure

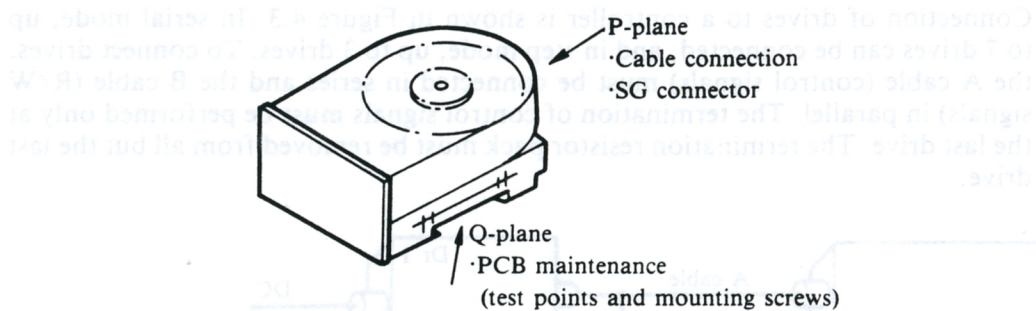
When the drive is secured with a side tap, the aluminum base surrounding the disks is the signal ground (SG). Hence, an embossed structure (or any other structure that does not touch the aluminum base) as shown below should be used to prevent the aluminum base from touching the frame ground (FG). The mounting screws should project no more than 4 mm from the outer wall of the drive mounting frame.



(3) Ambient temperature

The operating temperature range of the drive is specified at a distance of 3 cm from the drive.

(4) Service area



4.3 Cable Connection

4.3.1 Drive connectors location

As shown in Figure 4.2, the A and B cable edge and power connectors are connected to the bottom of the drive, and the SG connector to the bottom of the base.

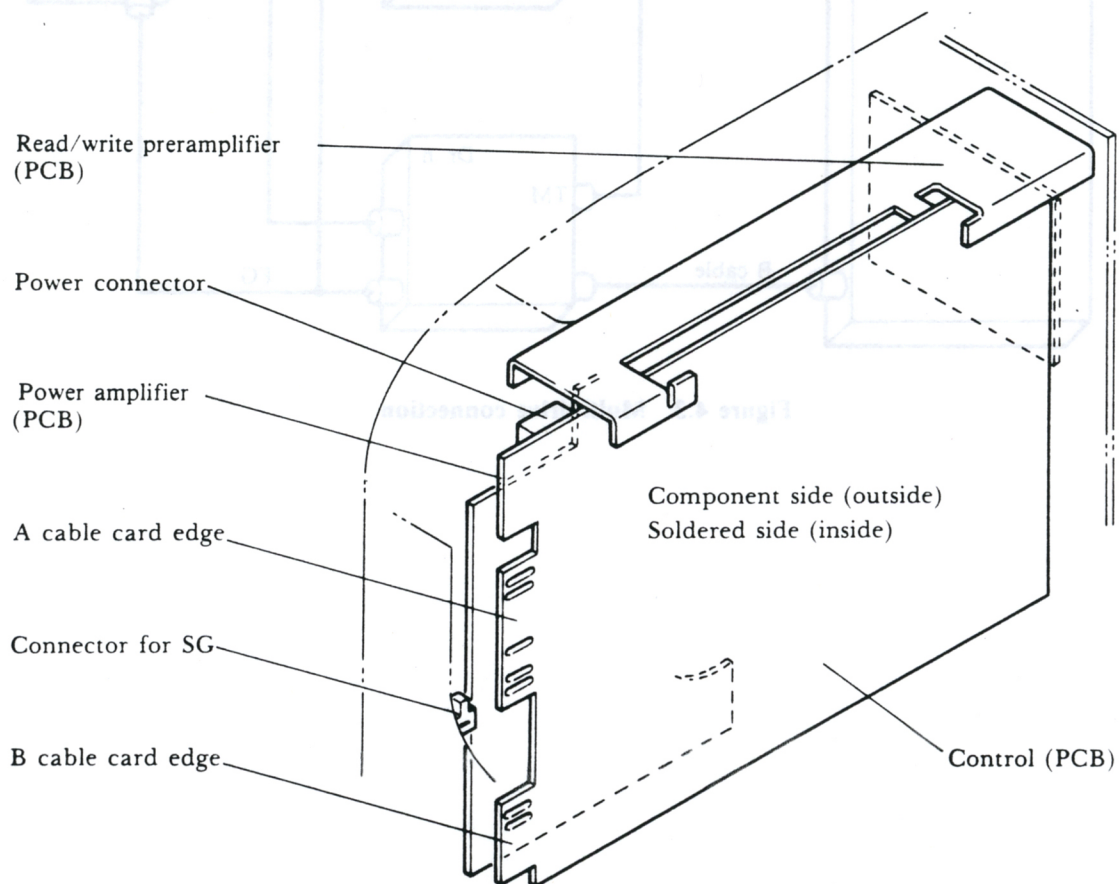


Figure 4.2 Drive connectors

4.3.2 Connection

Connection of drives to a controller is shown in Figure 4.3. In serial mode, up to 7 drives can be connected, and in step mode, up to 3 drives. To connect drives, the A cable (control signals) must be connected in series and the B cable (R/W signals) in parallel. The termination of control signals must be performed only at the last drive. The termination resistor pack must be removed from all but the last drive.

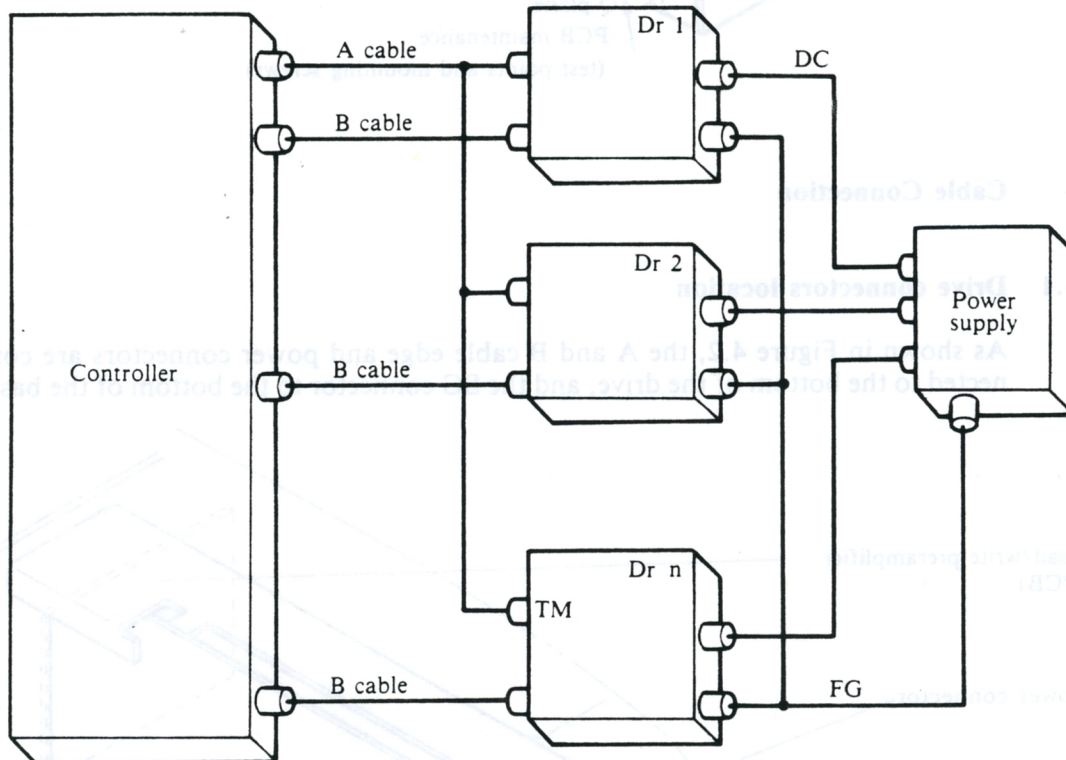


Figure 4.3 Multi-drive connection

4.4 Driver/Receiver

The interface signals are terminated as in Figure 4.4. The total control cable length in a multi-drive configuration should not exceed the specification.

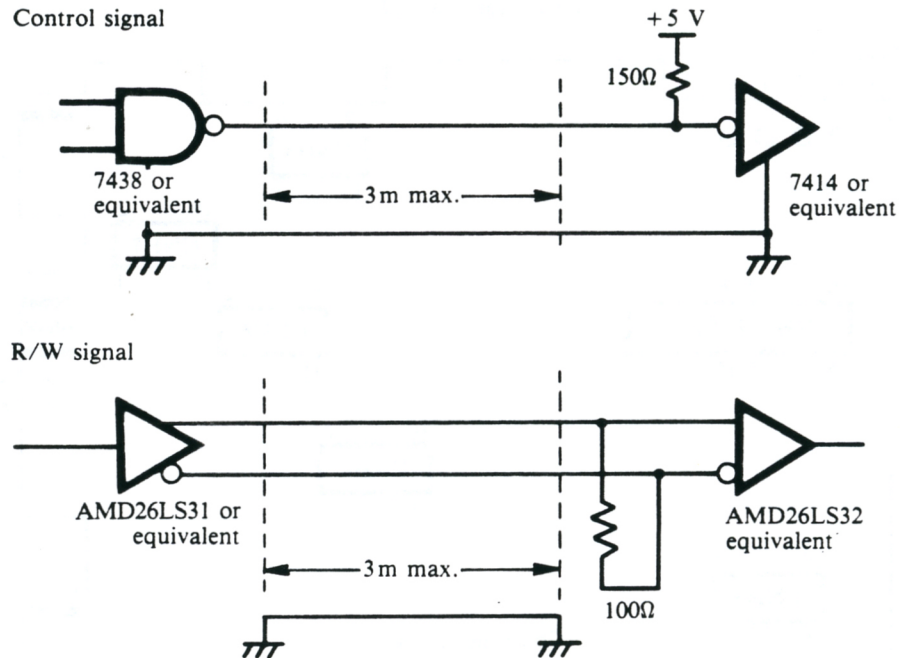


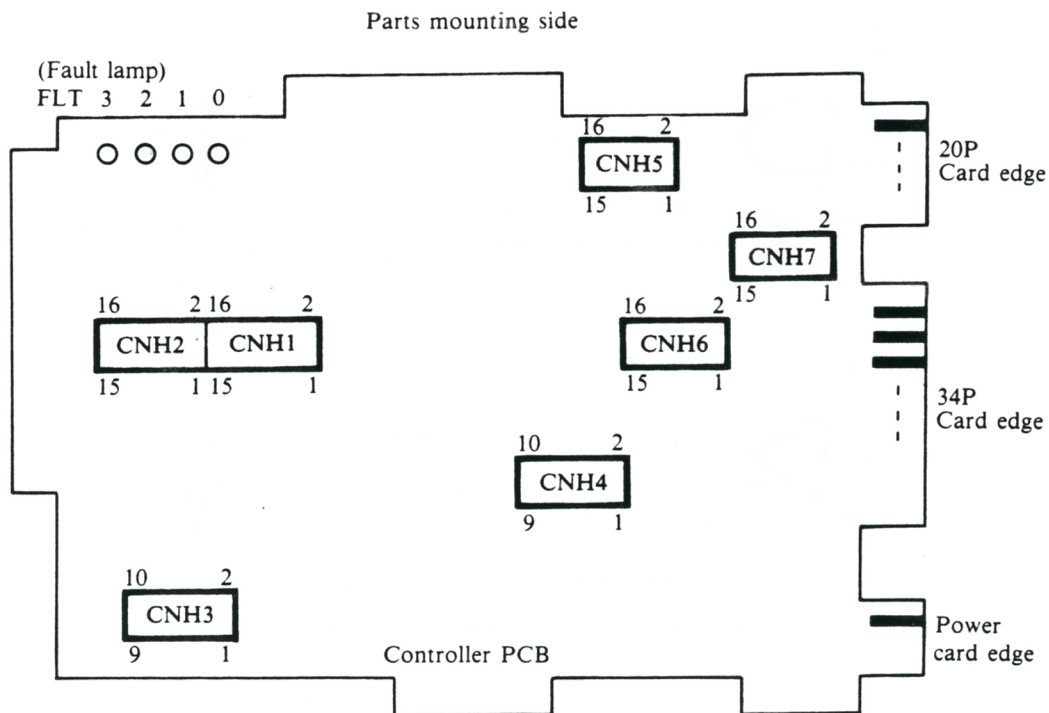
Figure 4.4 Driver/Receivers

4.5 DC Grounding

For DC ground, a fasten tab is provided as the SG connector (Figure 4.2).

4.6 Fault Lamps and Setting Plugs

4.6.1 Short circuits and fault lamp location



Short plugs are inserted as follows when shipped from the factory.

- CNH7: Between 1 and 2, 3 and 4, 9 and 10, and 15 and 16
- CNH6: Between 1 and 2, and 15 and 16
- CNH4: Between 3 and 4
- CNH2: Between 15 and 16

This varies according to the model as shown below.

- CNH7: Between 5 and 6: M2245E
- Between 7 and 8: M2246E
- No short plugs between 5 and 6, and 7 and 8: M2244E

4.6.2 Setting

Symbols in the tables have the following meanings.

O: Open
X: Short

(1) Drive select (drive number setting)

a. Serial mode

Drive number \ Location	CNH 6						
	1-2	3-4	5-6	7-8	9-10	11-12	13-14
1	O	X	X	X	X	X	X
2	X	O	X	X	X	X	X
3	X	X	O	X	X	X	X
4	X	X	X	O	X	X	X
5	X	X	X	X	O	X	X
6	X	X	X	X	X	O	X
7	X	X	X	X	X	X	O

b. Step mode

Drive number \ Location	CNH 6						
	1-2	3-4	5-6	7-8	9-10	11-12	13-14
1	O	X	X	X	X	X	X
2	X	O	X	X	X	X	X
3	X	X	X	O	X	X	X

(2) Radial option

The radial option sets or does not set the gate for the signal sent to the interface, according to the Drive Select signal.

Signal gate or not (select signal)	CNH6
	15 - 16
No gate (radial)	O
Gate (daisy)	X

(3) Other settings

Setting values are valid when the power is on.

a.

Location		Function
CNH7 1 - 2	O	Function for motor start control from interface: Yes No
	X	
CNH7 3 - 4	O	Step mode Serial mode
	X	

Note: The function for motor start control from the interface is valid in serial mode.

b.

CNH7		Device type selection
5 - 6	7 - 8	
X	X	M2244E
X	O	M2245E
O	X	M2246E

Note: Valid in serial mode

c.

CNH7		Sector mode setting
13 - 14	15 -16	
X	X	Drive hard sector (Sector)
X	O	Controller hard sector (Byte Clock)
O	X	Drive soft sector (Address Mark Found)

d.

CNH7		Sector setting
9 - 10	11 - 12	
X	X	16 Sectors/Track
X	O	32 Sectors/Track
O	X	64 Sectors/Track

Note: Valid in hard sector mode

4.6.3 Fault lamps

Drive fault states are displayed by the fault lamps (0, 1, 2, 3).

	Fault lamp 3 2 1 0	State
1	X X X O	DC motor revolutions fewer than 90% of standard
2	X X O X	VCM heat
3	X X O O	Initial Seek time over
4	X O X X	Write command during Seek operation
5	X O X O	+12 V/+5 V, less than 80% of standard
6	X O O X	Offtrack command during Write operation
7	X O O O	Error check
8	O X X X	Two or more head ICs selected during Write operation
9	O X X O	Seek time over
10	O X O X	Guard band detection during normal Seek operation
11	O X O O	Guard band detection in the linear mode
12	O O X X	Overshoot check
13	O O X O	Seek command outside area
14	O O O X	Head load signal fallen after READY
15	O O O O	Read and Write commands simultaneously issued

O: On
X: Off

Note 1: Item 13 is valid in step mode, but invalid in serial mode.

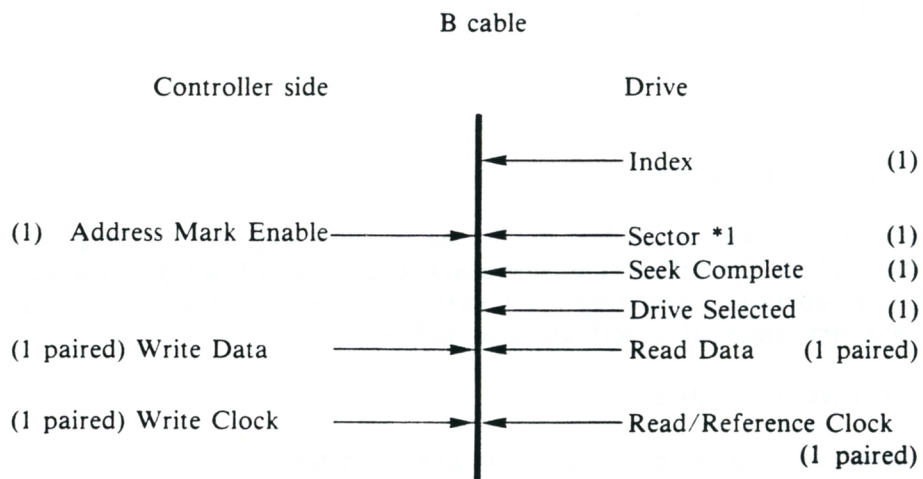
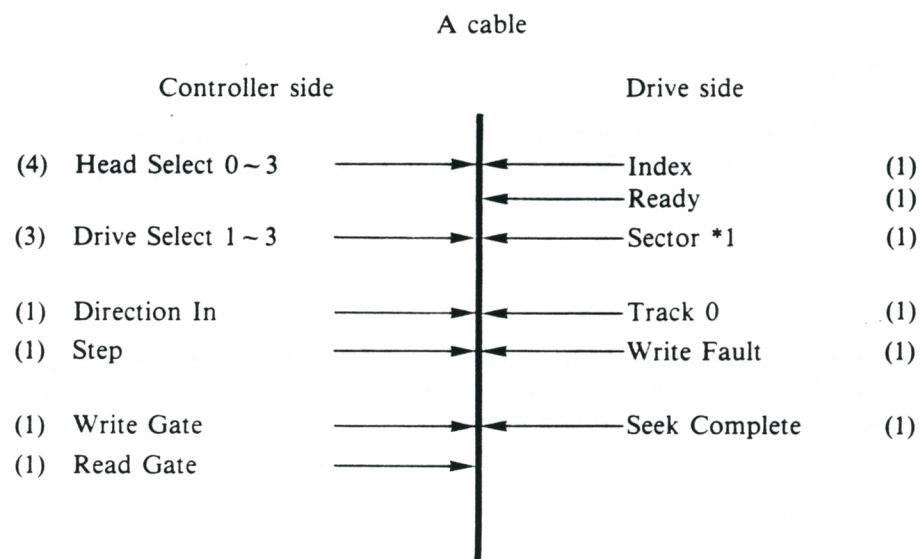
Note 2: Reset using Fault Clear (in serial mode) or Drive Select Clear (in step mode).
Item 2 can only be cleared with power off.

CHAPTER 5 INTERFACE

This chapter describes the physical and logical conditions of the signals transferred through the interface between the drive and the controller. The timing is specified at the driver/receiver location.

5.1 Step Mode

5.1.1 Signal lines



*1 The signal line consists of Sector, Byte Clock, or Address Mark Found signals, selected at the drive. The above figure shows Sector signal sending.

5.1.2 Input signals

(1) Head Select 0 to 3

These signal lines are used to select the head address, and up to 16 heads can be selected. However, one of up to 10 heads is selected in M224XE.

(2) Drive Select 1 to 3

These signal lines are used to select one of three drives in a multi-drive configuration and to validate the input/output signals of the selected drive.

(3) Direction In

This signal line is used to determine the seek direction of the data heads when step pulses are sent to the drive. When this signal is high, Seek is performed outward; when low, Seek is performed inward.

(4) Step

One transient (high→low) of this signal causes the Seek operation to be performed on data heads one track per pulse in the direction indicated by the Direction In signal. There are two stepping modes.

a. Slave step mode

When the step pulse rate is between 5 kHz and 250 kHz, the Seek operation does not start until all the step pulses have arrived. The Seek Complete signal becomes active when all Seeks have been completed.

Note: Step rates of 5 kHz or less are inhibited.

b. Return to zero mode

When 823 or more step pulses are issued in slave step mode, the data heads automatically perform the R.T.Z. operation, and move to Track 0. However, when the R.T.Z. operation (detecting Track 0) is performed in ordinary step mode, not the slave step mode, it is performed as follows.

- (1) Set Direction outward.
- (2) Send one step pulse, and perform one track Seek.
- (3) Wait until the Seek Complete signal is low.
- (4) Repeat the procedure until the Track 0 signal is low.

When the abnormalities given below occur in the Seek operation, the drive automatically performs the Seek operation in Track 0 by the internal initial recalibration function. The Seek Complete signal gives the same response as for normal termination of the seek operation.

(1) Illegal step pulses are received that cause the Seek operation to be performed for data heads outside the data area.

(2) A seek error occurs.

(5) Write Gate

This signal line enables write current to the selected data head in the drive.

(6) Read Gate

This signal line reads data from the selected data head in the drive. Read Data is validated by the Read Gate after 8 bytes (6.4 μ s).

(7) Write Data (balanced transmission)

This signal line transfers data written on the disk from the controller, and is an NRZ signal that is clocked by the Write Clock.

(8) Write Clock (balanced transmission)

This signal is a bit data cycle clock sent from the controller. The frequency is given by the Read/Reference clock during Write operation.

(9) Address Mark Enable

This signal writes the address mark when Write Gate is active, and is three bytes long. When neither the Write Gate nor the Read Gate has been active, it searches for the address mark.

5.1.3 Output signals

(1) Index

One pulse per disk revolution is generated, and the head of the track is indicated. The pulse is sent on both A and B cables.

(2) Ready

If the Seek Complete signal is low when the Ready signal is low, the Read, Write, and Seek operations are possible on the selected drive. The Ready signal is sent on both A and B Cables.

(3) Sector/Byte Clock/Address Mark Found

One track is divided into 16, 32, or 64 sectors, and sent as a sector pulse. However, number of sectors depends on switch selection. When the byte clock is necessary for the controller to obtain the various sectors, or when an address mark is used, the pulse is sent as Byte Clock or Address Mark Found. The selection depends on the drive switch setting.

(4) Track 0

This signal indicates that the data heads are positioned at Track 0.

(5) Write Fault

This signal indicates that one of the following abnormal states occurred during writing. It remains active until the abnormal state is reset.

- a. Either the +5 V or +12 V fell below specified tolerance.
- b. Write current was not applied to the head while Write Gate was enabled.
- c. Write Gate was enabled during a multi-head select condition or while no head was selected.

(6) Read Data (balanced transmission)

Read Data is in NRZ format. Read Data is validated by the Read Gate after 6.4 μ s. Read Data is sent when the Read Clock falls.

(7) Read/Reference Clock (balanced transmission)

This is a pulse at 1-bit intervals. The Read/Reference Clock is synchronized with the servo clock during Not Read, and with Read Data from the Data Head during Read. The controller uses this signal as a Write Clock during Write.

(8) Seek Complete

This signal indicates that the selected data head in the drive is positioned at the requested track. It includes the settling time of the head, and when it is low, Read/Write operations are enabled. It is sent on both A and B cables.

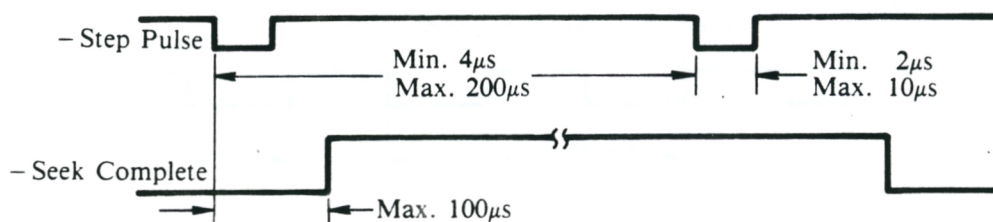
(9) Drive Selected

This signal indicates that the drive number specified by the controller matches the drive number set in the drive. It indicates that the drive has been selected.

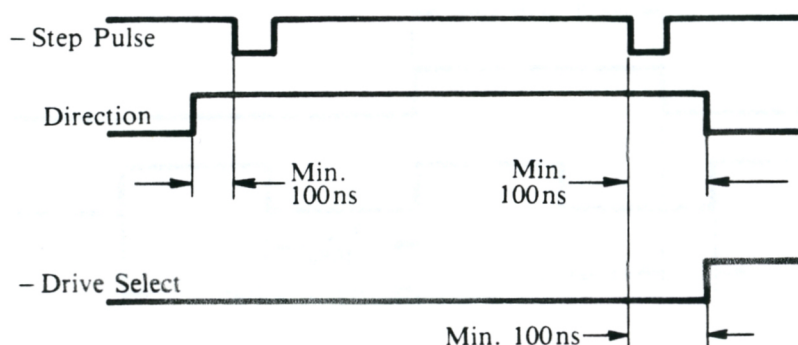
5.1.4 Timing specifications

(1) Seek timing

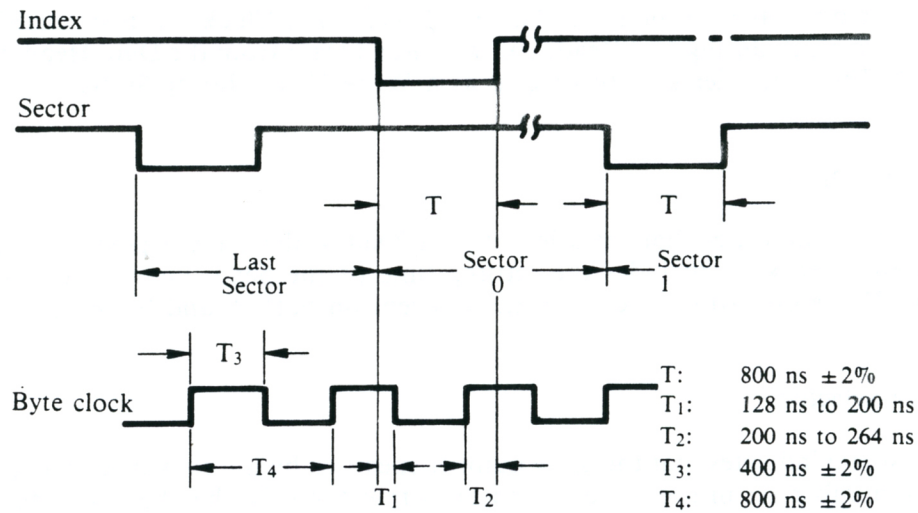
a. Step Pulse, Seek Complete



b. Step Pulse, Direction, Drive Select

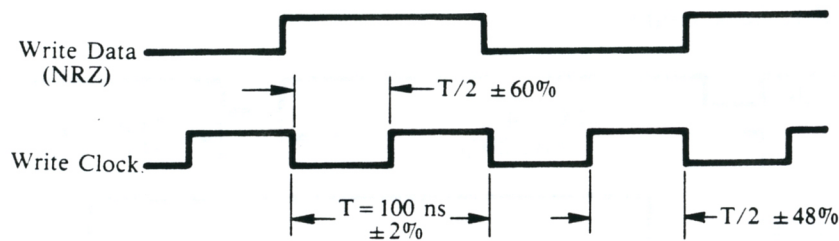


(2) Index/Sector/Byte Clocks timing

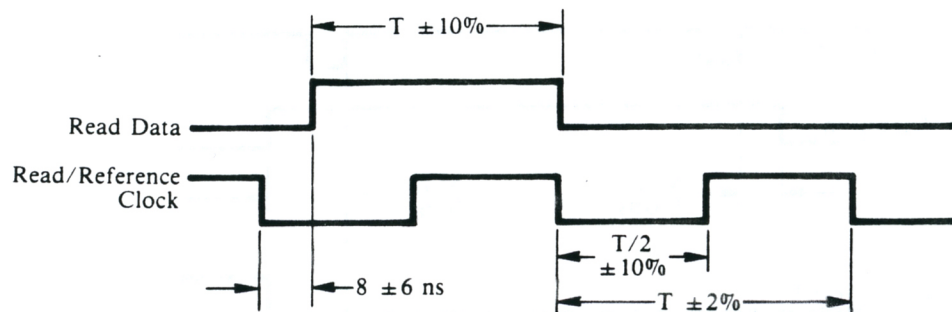


(3) Write/Read Data timing

a. Write Data, Write Clock



b. Read Data, Read/Reference Clock



5.1.5 Step mode signal lines pin assignment

(1) CNA signal lines pin assignment

2	– Head Select 2^3	1	GND
4	– Head Select 2^2	3	GND
6	– Write Gate	5	GND
8	– Seek Complete	7	GND
10	– Track 0	9	GND
12	– Write Fault	11	GND
14	– Head Select 2^0	13	GND
16	– SEC/ – BYTE CL/ – AMF	15	GND
18	– Head Select 2^1	17	GND
20	– Index	19	GND
22	– Ready	21	GND
24	– Step	23	GND
26	– Drive Select 1	25	GND
28	– Drive Select 2	27	GND
30	– Drive Select 3	29	GND
32	– Read Gate	31	GND
34	– Direction In	33	GND

Note 1: The key pin is between pin 4 and pin 6.

Note 2: – SEC/ – BYTE CL/ – AMF: Sector/Byte Clock/Address Mark Found

(2) CNB signal lines pin assignment

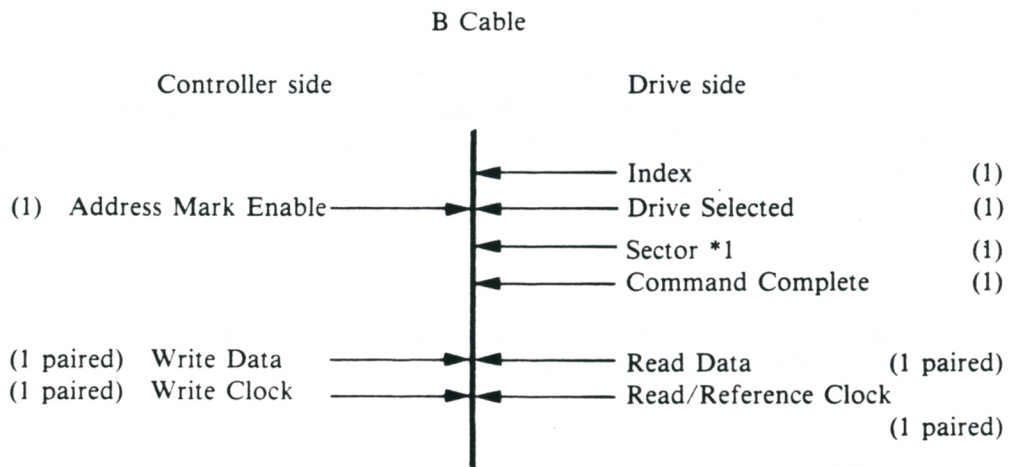
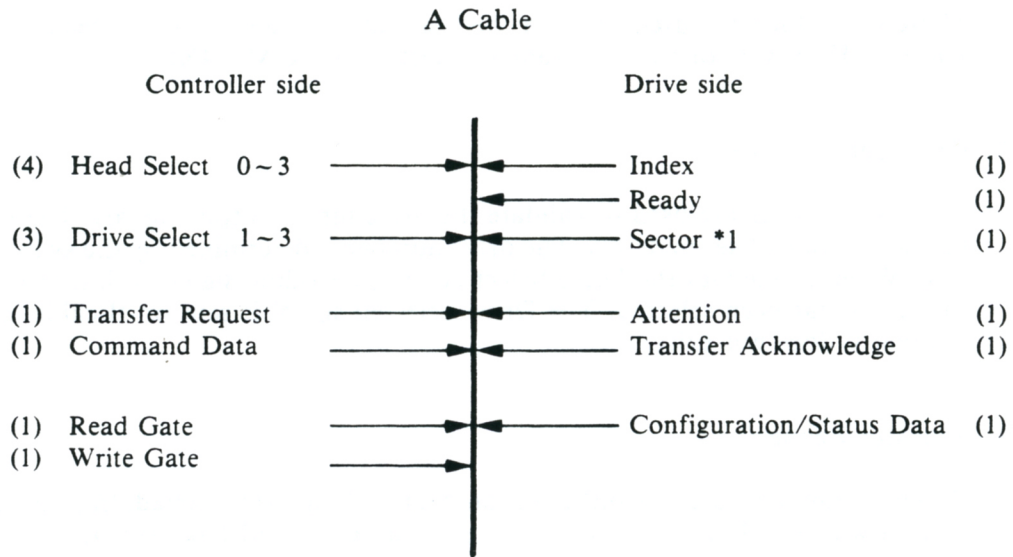
2	– SEC/ – BYTE CL/ – AMF	1	– Drive Selected
4	– Address Mark Enable	3	– Seek Complete
6	GND	5	Reserved (0 Level)
8	– Write Clock	7	+ Write Clock
10	+ Read/Reference Clock	9	Reserved (0 Level)
12	GND	11	– Read/Reference Clock
14	– NRZ Write Data	13	+ NRZ Write Data
16	GND	15	GND
18	– NRZ Read Data	17	+ NRZ Read Data
20	– Index	19	GND

Note 1: The key pin is between pin 8 and pin 10.

Note 2: – SEC/ – BYTE CL/ – AMF: Sector/Byte Clock/Address Mark Found

5.2 Serial Mode

5.2.1 Signal lines



*1 The signal line consists of sector, byte clock, or address mark found signals, selected at the drive. The above figures show sector signal sending.

5.2.2 Input signals

(1) Head Select 0 to 3

These signal lines are used to select the head address, and up to 16 heads can be selected. However, one of 10 heads is selected in the M224XE.

(2) Drive Select 1 to 3

These signal lines are used to validate the drive input/output signals. The signal line selects one of seven drives. The drive number is determined by the switch setting. When it matches the Drive Select (1 to 3) decoding signal, it indicates that that drive has been selected. The Drive Selected signal is sent on B cable. Drive number 0 does not exist.

(3) Transfer Request

When Command Data or Configuration/Status Data is transferred, this signal line is used with the Transfer Acknowledge signal as a handshake signal.

(4) Command Data

This signal line accepts commands controlling the drive. It is 16-bit sequential data with odd parity. This signal is transferred from the controller to the drive by the Transfer Request and Transfer Acknowledge signals. Transfer is performed from the most significant bit.

(5) Read Gate

This signal line reads data from the selected data head in the drive. Read data is valid 6.4 μ s after the read gate has risen.

(6) Write Gate

This signal line enables Write current in the selected data head in the drive.

(7) Write Clock (balanced transmission)

This is a bit data cycle clock sent from the controller. The frequency is given by the Read/Reference Clock during Write.

(8) Write Data (balanced transmission)

This signal line sends data written on the disk from the controller, and is an NRZ signal that is clocked by the Write Clock.

(9) Address Mark Enable

This signal writes the address mark when Write Gate is active, and is three bytes long. When neither the Write Gate nor the Read Gate have risen, it searches for the address mark.

5.2.3 Output signals

(1) Index

One pulse per disk revolution is produced, and the head of the track is indicated.

(2) Ready

If the Seek Complete signal is low when this signal is low, the Read, Write, and Seek operations are possible on the selected drive.

(3) Sector/Byte Clock/Address Mark Found

One of these three signals is selected as necessary by the switch.

(4) Attention

This signal sends a standard status request to the controller. The signal indicates that fault or status changes have occurred, and that the Write operation is inhibited. It is reset by the control command.

(5) Transfer Acknowledge

This signal is used in Command Data and Configuration/Status signal handshake transfers.

(6) Configuration/Status Data

When commands are received from the controller, this signal sends each status to the controller. This signal is 16-bit serial data with odd parity. It is transferred when a handshake occurs between the Transfer Request and Transfer Acknowledge signals. Transfer is performed from the most significant bit.

(7) Drive Selected

This signal indicates that the drive number specified by the controller matches the drive number set in the drive. It indicates that the drive has been selected.

(8) Command Complete

This signal is sent even when the drive has not been selected. The gate is not enabled by the Drive Selected signal. This signal is high under the conditions given below.

- a. After power-on until cylinder 0 is on track (until initial seek is complete)
- b. From when Command Data is received to when the command is complete

(9) Read Data (balanced transmission)

Read Data becomes valid 6.4 μ s after Read Gate. It is sent synchronized with the Read Clock fall.

(10) Read/Reference Clock

This is a pulse at 1-bit intervals. The Read/Reference Clock is synchronized with the servo clock during Not Read, and with Read Data from the data head during Read.

5.2.4 Command data format

Command data format is 17 bits, 16 bits + 1 parity, and is shown in the table below.

MSB																LSB
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	P
Function bit				Modifier bit				All zeros								P
Function bit				Parameter bit												P

P : Parity (Odd)

(1) Function/Modifier/Parameter bit

Function bit				Command function definition	Modifier bit 11 to 8	Parameter bit 11 to 0	Configuration/ Status Data
15	14	13	12				
0	0	0	0	Seek	No	Yes	No
0	0	0	1	Recalibrate	No	No	No
0	0	1	0	Request Status	Yes	No	Yes
0	0	1	1	Request Configuration	Yes	No	Yes
0	1	0	0	(Reserved)	—	—	—
0	1	0	1	Control	Yes	No	No
0	1	1	0	(Reserved)	—	—	—
0	1	1	1	Track Offset	Yes	No	No
1	0	0	0	Initiate Diagnostics	No	No	No
1	0	0	1	Set Bytes/Sector	No	Yes	No
1	0	1	0	(Reserved)	—	—	—
1	0	1	1	(Reserved)	—	—	—
1	1	0	0	(Reserved)	—	—	—
1	1	0	1	(Reserved)	—	—	—
1	1	1	0	(Reserved)	—	—	—
1	1	1	1	(Reserved)	—	—	—

Note 1: All unused bits must be set to 0.

Note 2: When (Reserved) is received, an invalid command is sent in reply.

a. Seek (0000)

Seek is performed in the cylinder specified by bits 0 to 11.

b. Recalibrate (0001)

Seek (R.T.Z.) is performed in cylinder 0. The Track Offset is reset.

c. Request Status (0010)

This is used when the controller requires a status held by the drive. Status defined at bits 11 to 8 is sent to the controller side at 16-bit data with odd parity. In the condition shown in the following table, bits 11 to 8 are all zeros.

Bit Position	Function	Bit details
15	(Reserved)	0
14	Removable Media Not Present	1
13	Write Protected	0
12	Write Protected	0
11	(Reserved)	0
10	(Reserved)	0
9	Spindle Motor Stopped	X (0)
8	Power On Reset Conditions Exist	X (0)
7	Command Data Parity Fault	X (0)
6	Interface Fault	X (0)
5	Invalid command Fault	X (0)
4	Seek Fault	X (0)
3	Write Fault Offset	X (0)
2	Vendor Unique Status Available	0
1	Write Fault	X (0)
0	Removable Media Changed	0

Note: X varies according to the drive status. Numbers in parentheses show the normal status.

d. Request Configuration (0011)

Specified drive specifications are sent to the controller. Specifications are determined by combinations of bits 11 to 8.

Command modifier bit				Function
11	10	9	8	
0	0	0	0	General Configuration
0	0	0	1	Number of Cylinders (Fixed)
0	0	1	0	—
0	0	1	1	Number of Heads
0	1	0	0	Min. Unformatted Bytes/Track
0	1	0	1	Unformatted Bytes/ Sector (Hard Sector)
0	1	1	0	Sectors/Track (Hard Sector)
0	1	1	1	Min. Bytes/ISG Field
1	0	0	0	Min. Bytes/PLO Sync Field
1	0	0	1	—

e. Control (0101)

This command has the control functions shown in the table below.

Command Modifier bit				Function
11	10	9	8	
0	0	0	0	Reset Interface Attention & Standard Status
0	0	0	1	(Reserved)
0	0	1	0	Stop Spindle Motor*
0	0	1	1	Start Spindle Motor*
0	1	0	0	(Reserved)
0	1	0	1	(Reserved)
0	1	1	0	(Reserved)
0	1	1	1	(Reserved)
1	X	X	X	(Reserved)

* This function is valid only when the drive is set to support spindle motor start/stop. When it is not set, rotation starts with power-on, and an invalid command is sent in reply.

f. Track Offset (0111)

This command sets offset during ontrack. The offset value and direction are selected by a combination of bits 11 to 8. Offset is reset by the Seek or R.T.Z. command.

Command modifier bit				Function
11	10	9	8	
0	0	0	0	Restore offset to 0
0	0	0	1	Restore offset to 0
0	0	1	0	Positive offset 1
0	0	1	1	Negative offset 1
0	1	0	0	Positive offset 2
0	1	0	1	Negative offset 2
0	1	1	0	Positive offset 3
0	1	1	1	Negative offset 3
1	X	X	X	(Reserved)

g. Initiate Diagnostics (1000)

This command performs drive diagnostics. Command Complete is sent when the diagnostics terminate normally, and Attention is sent with Command Complete after it terminates abnormally.

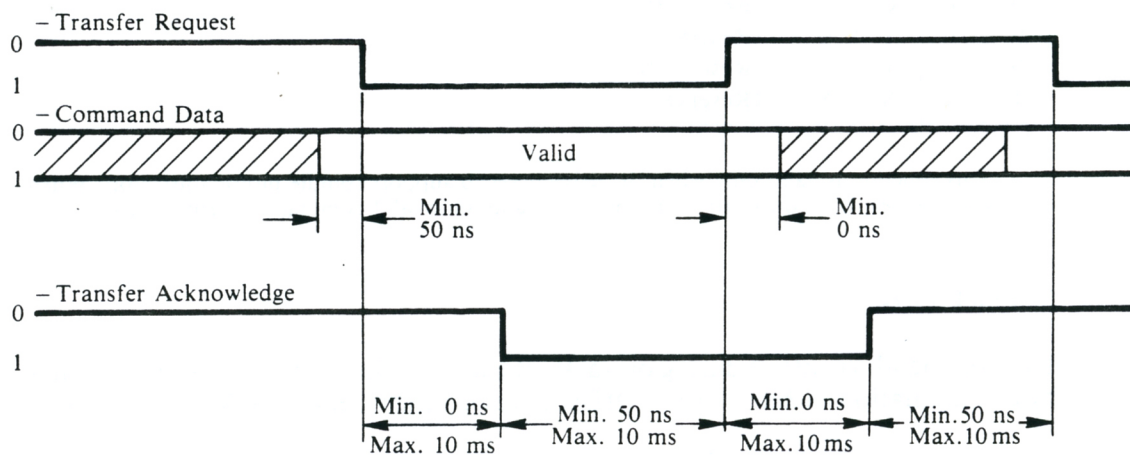
h. Set Unformatted Bytes/Sector (1001)

The number of unformatted bytes per sector are sent to bits 11 to 0. This command is only valid for hard sector drive.

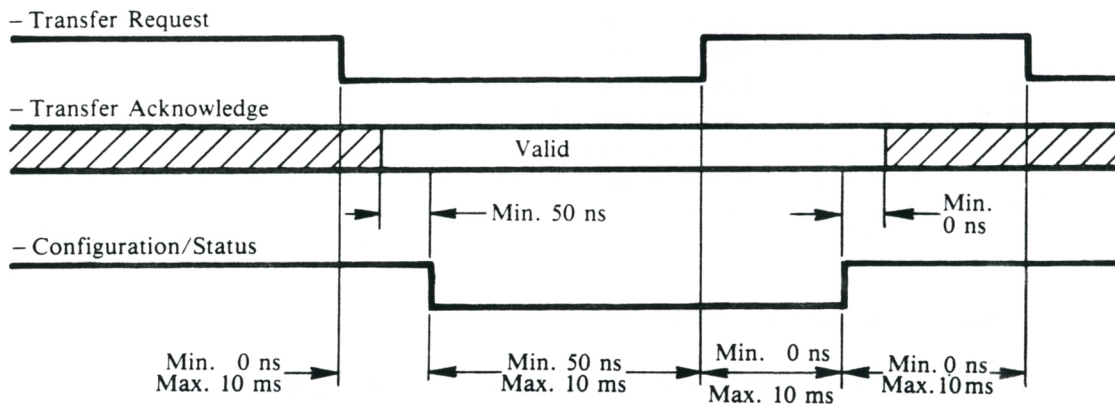
i. (1010) to (1111) are undefined.

5.2.5 Timing specifications

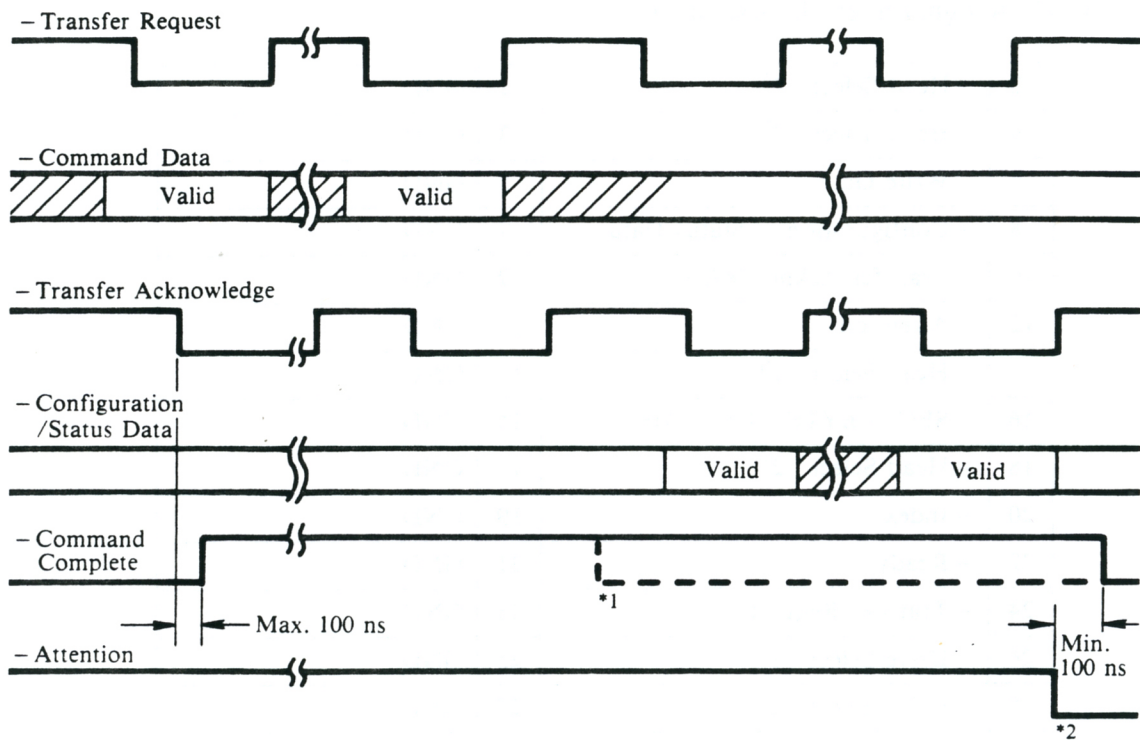
(1) Command Data



(2) Transfer Request



(3) Command and Configuration/Status Data



*1 When the controller does not need the response of Configuration/Status Data, Complete is sent when the command has been executed.

*2 Attention rises with Command Complete when an error occurs.

5.2.6 Serial mode signal lines pin assignment

(1) CNA signal lines pin assignment

2	– Head Select 2^3	1	GND
4	– Head Select 2^2	3	GND
6	– Write Gate	5	GND
8	– Configuration/ – Status Data	7	GND
10	– Transfer Acknowledge	9	GND
12	– Attention	11	GND
14	– Head Select 2^0	13	GND
16	– SEC/ – BYTE CL/ – AMF	15	GND
18	– Head Select 2^1	17	GND
20	– Index	19	GND
22	– Ready	21	GND
24	– Transfer Request	23	GND
26	– Drive Select 1	25	GND
28	– Drive Select 2	27	GND
30	– Drive Select 3	29	GND
32	– Read Gate	31	GND
34	– Command Data	33	GND

Note 1: The key pin is between pin 4 and pin 6.

Note 2: – SEC/ – BYTE CL/ – AMF: Sector/Byte Clock/Address Mark Found

(2) CNB signal lines arrangement

2	– SEC/ – BYTE CL/ – AMF	1	– Drive Selected
4	– Address Mark Enable	3	– Command Complete
6	GND	5	– Reserved (0 Level)
8	– Write Clock	7	+ Write Clock
10	+ Read/Reference Clock	9	Reserved (0 Level)
12	GND	11	– Read/Reference Clock
14	– NRZ Write Data	13	+ NRZ Write Data
16	GND	15	GND
18	– NRZ Read Data	17	+ NRZ Read Data
20	– Index	19	GND

Note 1: The key pin is between pin 8 and pin 10.

Note 2: – SEC/ – BYTE CL/ – AMF: Sector/Byte Clock/Address Mark Found

CHAPTER 6 DRIVE SPECIFICATIONS

Table 6.1 shows models and part numbers.

Table 6.1 Models and part numbers

Item	Model	Part number	Mounting screw
1	M2244E	B03B-4805-B101A	M4
2	M2245E	B03B-4805-B102A	M4
3	M2246E	B03B-4805-B103A	M4

Note: The mounting screw is #6-32UNC when #N is added to the part number.

For example, M2244E: B03B-4805-B101A #N

CHAPTER 7 SPARE PARTS

Table 7.1 shows spare parts and numbers.

Table 7.1 Spare parts

Item	Part name	Number
1	Controller PCB	B17B-0370-0020A
2	Power amplifier PCB	B17B-0380-0010A
3	Read/write preamplifier PCB	B17B-0390-0010A

